Distortion Studies for the FOPI GEM-TPC*

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A TPC (Time Projection Chamber) with a GEM readout was employed inside the FOPI [1] detector for several tests and a physics experiment with a pion beam. This TPC has an cylindrical fieldcage with with an driftlengh of 72.28 cm an outer diameter of 15 cm and an inner diameter of 5 cm. For field homogenization the fieldcage consists of more than 900 strips at the inner as well as on the outer fieldcage. The distance from the GEMs to the fieldcage strip with the lowest potential – the last strip – is 3.5 cm. The potential on this last strip can be set to define the voltage drop over the fieldcage and the field between the last strip and the GEMs. Since inhomogeneities in the occupancy suggested the presence of distortions and the estimated spatial resolution was worse than the expected value confirmed by [2], a detailed modeling of the drift field is necessary to reproduce quantitatively the distortion effects

Fieldcage Simulation

For this purpose a FEM simulation of the electric field inside the fieldcage was carried out. The first results of this simulation can be seen in Figure 1 where the radial electric field component and the component along the TPC symmetry axis is plotted. In this first simulation the setting for the field as they were used during the tests with the cosmic particles were implemented. These settings include a drift field of 309.6 V/cm and the potential of the last strip was set to 70 V. Furthermore the first strip after the cathode is on the same potential. To simplify the calculations azimuthal symmetry of the field was assumed. One can see from Figure 1 that the first as well as the last strip are sources of field distortions. A unwanted radial component of the drift field appears at the positions of these strips which leads to distorted electron drift paths.

Distortions

With the knowledge of the effective drift field and the magnetic field, the Langevin equation can be solved numerically in order to obtain a map of drift distortions as a function of the starting point of the drift [3]. For the magnetic field, the FOPI field map was used. Figure 2 shows the distortion of electrons as a function of the radius and the position along the drift. The distortion map will be used as an input for a Monte Carlo simulation to reproduce the

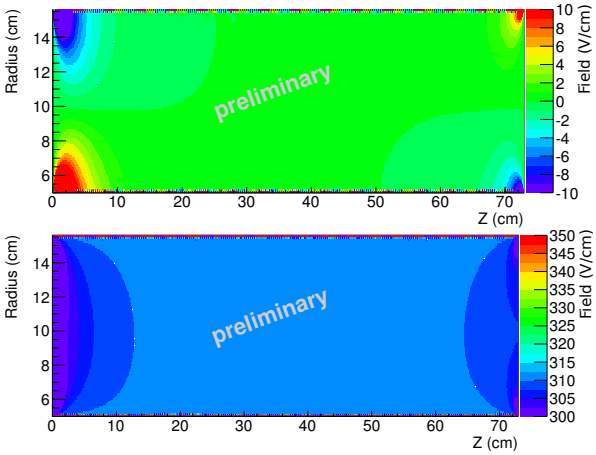

Figure 1: The electric field inside the TPC prototype for 309.6 V/cm drift field and 70 V potential at the last strip. The radial and along the beam axis component of the electric field inside the GEM-TPC is shown in the upper and lower panels respectively.

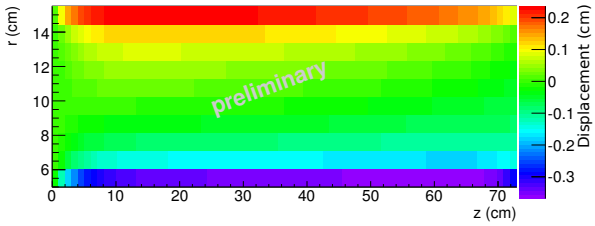

Figure 2: The displacement in radial direction in cm for an electron starting at a given position.

experimentally found inhomogeneities in the spacial resolution. A first evaluation of the experimental data agrees qualitatively with assumption that the distortions are linked to the last strip settings.

References

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